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NASA TECH BRIEF

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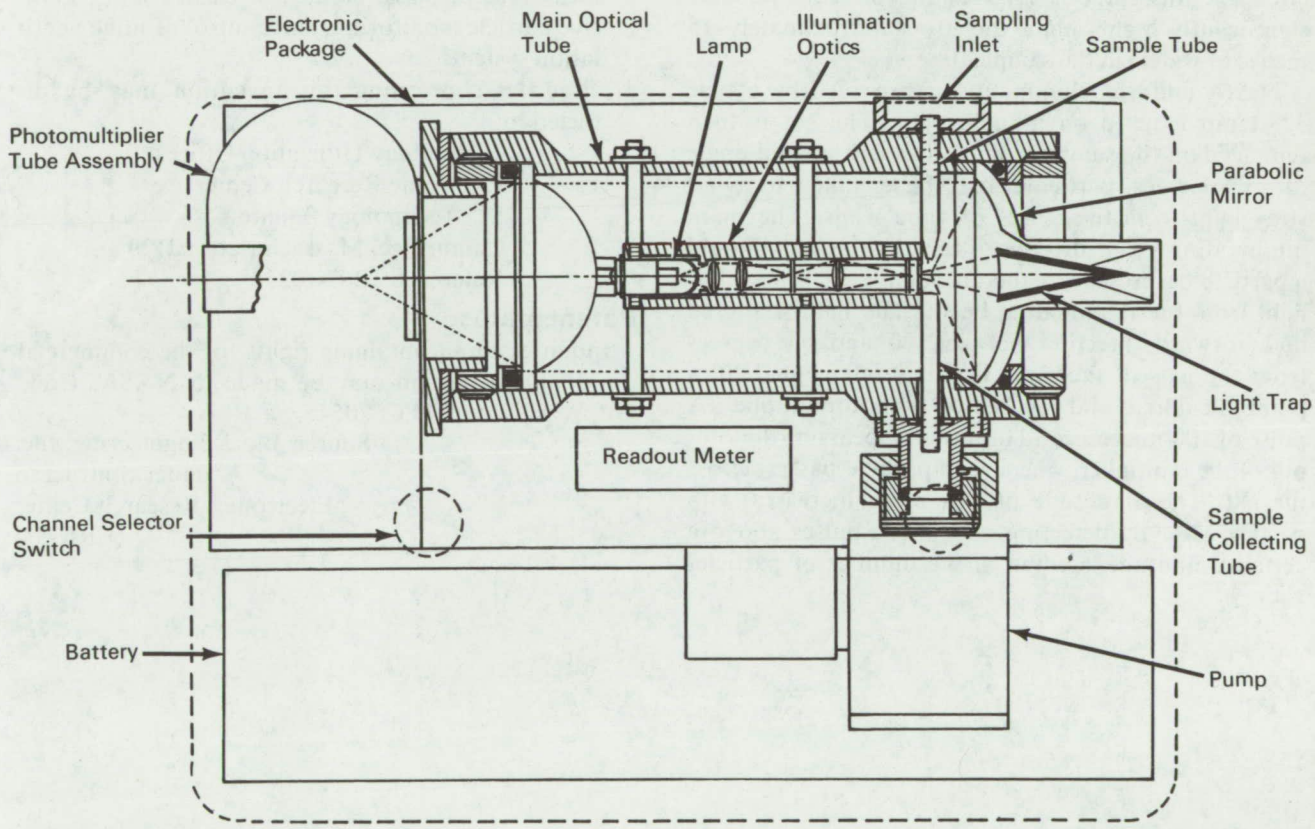
Improved Atmospheric Particle Analyzer



The problem:

To design an instrument that will measure aerosol particle concentrations in the range of 500 to 500,000 particles per cubic foot and size distributions in the range of 0.5 to 10 microns. The sampling rate of the instrument must be high enough to provide accurate readings within a reasonable time.

The solution:

An electro-optical instrument (nephelometer) that measures the light scattered from the aerosol particles at a controlled sampling rate to ensure laminar flow through the sample tube, and thereby eliminate the need for sheath air. This instrument employs a concentric configuration, wherein the scattering angle is

(continued overleaf)

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concentric with, but outside the illuminating beam. An evaluation of conventional particle-size analyzers based on optical scattering phenomena indicates that the concentric configuration is preferable for measuring small aerosol particles of unknown refractive index.

How it's done:

Air to be sampled is drawn through the sampling inlet, located at the top of the instrument. This air passes through the sample volume, which has a diameter of 1 millimeter and a length that does not exceed 5 times this dimension. The air then passes through the collecting tube from where it is exhausted through the pump, which is driven by a permanent magnet motor. The velocity of the flow is 10 meters per second, which is equivalent to 0.465 liter per minute, or 1 cubic foot per hour. Reduced pressure (or an oxygen environment) will not have an appreciable effect on this rate, as long as the pressure remains significantly higher than the loss (approximately 15 inches of water) in the sample tube.

Nearly uniform illumination is provided by a type 328 lamp focused on a square slit. The slit is then reimaged on the sample volume through a solid angle of ± 12 degrees, particular care being taken to avoid stray light from the lenses or tube walls. The main illuminating beam diverges into a light trap. Should a particle be present in the air sample, it will scatter light from the illuminating beam. The light scattered in a forward direction between 30 and 53 degrees from the axis of the main beam is intercepted by a parabolic mirror and focused on a photomultiplier. A pulse of 100-microsecond duration appears at the output of the multiplier, whenever a particle passes across the slit. The amplitude of this pulse increases with particle size. By detecting only those pulses above a certain amplitude, a count of the number of particles above a given size is obtained. The detection is accomplished by simultaneously counting pulses in 5 discriminators, each set at a different amplitude. The output of each discriminator is integrated, using an integration time constant of 8 seconds, and the number of particles per second is then available as a dc voltage. This voltage is measured at the end of the sampling time by connecting the output meter sequentially to each of the output channels by means of the channel selector switch.

Power for the lamp, motor, and electronic circuitry is obtained from a 6.2-volt regulator, which is supplied from a 7.2-volt, 750-milliampere-hour nickel-cadmium battery.

Notes:

1. The output from this instrument is suitable for either analog or digital pulse processing.
2. This instrument should be useful in air pollution measurements, dust control in clean rooms, abrasive particle monitoring, and control of mine ventilation systems.
3. Inquiries concerning this invention may be directed to:

   Technology Utilization Officer
   Electronic Research Center
   575 Technology Square
   Cambridge, Massachusetts 02139
   Reference: B67-10231

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Source: Block Engineering, Inc.
under contract to
Electronics Research Center
(ERC-33)